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Proposal for Fish Sanctuary Declaration

(Mahseer Conservation Area, Lower Karnali, Kailali/
Asala Conservation Area, Rakam Karnali, Dailekh/
Asala Conservation Area, West Seti, Bajhang)

Resources Himalaya Foundation
and
Central Department of Environmental Science-TU

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Contributors

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Summary

Watershed and the river ecosystems of Nepal are under massive pressure from detrimental anthropogenic activities such as over-extraction of biotic and abiotic resources, dam construction, pollution, and sedimentation, which is deteriorating the pristine river health and declining the population of ecologically important aquatic species. Much literature published from government and non-government institutions, academia, private institutions, and independent expert researchers through ground-based consultation with local stakeholders, community-based organizations, and media groups, reported that there is only a limited conservation effort on freshwater biodiversity of Nepal. In this regard, the proposal aims to facilitate the establishment of a fish sanctuary focusing on the conservation of keystone species like Mahseer (*Tor putitora*) in lower Karnali, Asala (*Schizothorax* sp.) in Rakam Karnali, and West Seti of Karnali River Basin. Establishing a fish sanctuary will be an effective tool for conserving the targeted key fish species, preserving aquatic ecosystems and biodiversity, and increasing fish production in the freshwater systems. This proposal is prepared in consultation with experts and stakeholders, and considering the previous study and practices of community - based aquatic animal conservation groups, and formulated aquatic animal and aquatic biodiversity conservation acts by rural/urban municipalities.

The fish sanctuary can be renamed as Mahseer or Asala conservation area. It is a purely demarcated conservation area, where the targeted fish species will be reproduced, protected, and restored in the respective river system maintaining aquatic ecosystems as well as improving the livelihood of local communities, on which they are highly contingent. Mainstreaming the fish sanctuary declaration at the national level is consuming a longer time than expected even though it is one of the main targets, globally and nationally. This proposal is the initial step toward the conservation effort of ecologically important fish in the natural river systems at the local level.

1. Introduction

1.1 Background

Aquatic ecosystems including marine and inland freshwater biodiversity are degrading and declining rapidly. Approximately, 1% of the earth's surface is occupied by freshwater habitat and serves as hotspots of around 10% of the world's known species (Strayer and Dudgeon, 2010). Valuable ecosystem services provided in terms of economic, cultural, aesthetic, scientific, and education (Dudgeon et al., 2006) are unbalanced due to climatic and human activities. Rising water temperature due to climate change and anthropogenic activities such as water abstraction for hydropower and irrigation, habitat fragmentation and degradation, drainage, pollution, overfishing, sand, and gravel mining exerts threat to the inland fisheries and riverine ecosystems (Hijioka et al., 2014). To conserve the marine biodiversity and aquatic ecosystems, protected areas including marine reserves, marine sanctuaries, ocean sanctuaries, marine parks, and no-go zone have been established and managed. Similarly, river fish sanctuaries, community-based fish sanctuaries, etc. are introduced for improving fish biodiversity and fish production in inland water bodies under the co-management approach (Mustafa et al., 2017). Community-based fish sanctuaries are managed in Bangladesh (Sultana and Thompson, 2007) and other countries in the world. The size of the fish sanctuary ranges from less than 5 km (e.g., the White River Fish Sanctuary[1] in Jamaica to some are more than 60 km (e.g., Poonch River Mahseer National Park, Pakistan).

A fish sanctuary, a conservation area, is established to set aside a particular area in the water body as a permanent shelter for targeted fish species for natural propagation and protection. The establishment of a fish sanctuary is one of the effective tools for conserving fish stock, preserving biodiversity, and increasing fish production (Abu Naser, 2010). Fish congregate in the sanctuary for shelter, spend a peaceful life without any disturbance, and move autonomously for feeding and breeding purposes. The impacts of a fish sanctuary are positive in almost all cases including fish production, protection of the aquatic ecosystem, and socio-economic condition of the local fishing communities. No adverse impact on the environment has been found or reported by establishing a fish sanctuary. Furthermore, as a part and form of fisheries management, sanctuaries are relatively easy for user communities to implement and enforce as a management tool.

1 (https://whiteriverfishsanctuary.com)

1.2 Rationale for developing a fish sanctuary

Many researchers have shown that overexploitation of species and other river resources, the introduction of exotic species in native fish habitat or translocation of native species in another water system, pollution from urban, industrial, and agricultural areas, habitat loss and alteration through damming and water diversion, are the major contributing factors in declination of aquatic biodiversity (ADB, 2018). Out of 256 species of fish recorded in Nepal (Shrestha and Thapa 2020), 21 are enlisted in the threatened category; three as critically endangered, one as endangered, four as vulnerable, and thirteen as near threatened (Rajbanshi, 2013). Furthermore, due to the recent shift in the federal government system, the government is commencing loads of developmental activities such as hydropower, irrigation channel, and road construction in and around the river basins. For example, in Karnali River Basin, three large-scale hydropower dams are planned along the main-stream including Upper, Middle, and Chisapani Karnali with additional 40 small scales on its tributary steams throughout the watershed (Bennett, 2020). Development projects in Karnali River Basin are not limited to hydropower but also extended to large-scale irrigation channels, road construction, urbanization, industrialization, and change in agricultural practices, etc. On the other hand, only 14% of the river basin is protected, either as conservation areas or national parks and hunting reserves while a large portion of the area is still prone to such changes. Further, research on the effect of these anthropogenic activities on fish behavior, migration, and reproduction is scarce and receives negligible conservation attention. As a result, fish and other valuable aquatic resources, a key component of the freshwater aquatic ecosystem, are becoming more vulnerable. This current situation urges us to protect and conserve aquatic biodiversity to maintain the balance in nature and ensure the availability of resources for future generations.

Despite having national to the local level institutional arrangements and supporting policies for fish sanctuary, implementation of policies could be a major barrier to the effectiveness of the sanctuary. As we lack a specific fish sanctuary policy, this program will have to work under several policies, which could bring conflicting views between several institutional arrangements. Although these institutions have different responsibilities, conflict may occur either within government agencies from governance to budget distribution and approving activities or between local communities and government agencies during the implementation of operational and management plan, or within the communities (upstream and downstream users, near and distant users, high

and low caste users, male and female users, rich and poor users) from forming community level fish sanctuary committee to implementing activities, and benefit-sharing. Brief guidelines on institutions and stakeholder's role and their right, equitable benefit sharing, and social inclusion will be required to address and minimize such issues during the implementation phase.

Taking account of such massive threats in the freshwater ecosystems, the government of Nepal, in the National Biodiversity Strategy and Action Plan (2014-2020), targeted the establishment of three sanctuaries by 2017 (GoN/MoFSC, 2014). However, no attempt was made to fulfill this target and got readily omitted. Considering government commitments toward meeting the international targets such as the Aichi target (2011-2020), Sustainable Development Goals (2015-2030), especially SDGs 6 and 13, there is currently a need for fish sanctuary in Nepal to protect endangered species and maintain their suitable population structure in the major river systems. This proposal for declaring a fish sanctuary for keystone fish species in the Karnali River Basin would be an initial step towards fish conservation in Nepal and also a significant contribution to meet overlooked targeted national and international goals.

1.3 Objectives of the proposed fish sanctuary

The general objective of the fish sanctuary is to conserve/protect ecologically and economically important/keystone fishes as well as aid in the conservation of the entire river ecosystem by maintaining their suitable population structure, providing safe breeding and feeding grounds, and improving the livelihood of local communities.

The specific objectives of the fish sanctuary are to:

- protect the fish from genetic pollution with safe nursing and foraging grounds,
- conserve and restore aquatic habitats for maintaining ecological processes/balance,
- protect threatened/endangered species as well as other aquatic fauna and flora to increase aquatic biodiversity,
- enhance fish production for improving the livelihoods of local communities.

1.4 Process for fish sanctuary declaration

Fish sanctuary in the Karnali River Basin can be declared by following the fish sanctuary delineation protocol prepared in consultation with different stakeholders including local, provincial, and central governments. This protocol includes a basic background of biodiversity, particularly aquatic, fish of fish sanctuary, the key guidelines for site selection, approval process, and management framework. The detailed steps for sanctuary site identification and declaration are described below.

Step I. Potential hotspots identification

Potential hotspots for fish sanctuary will be identified by collecting detailed information on geophysical, and ecological aspects of the river systems, the status of fish and other biodiversity, socio-economy, land use, and land cover of the proposed area.

- Detailed geophysical and ecological information: Desk review of published articles and reports and preliminary field study will be conducted to collect general information of geological, hydrological, biodiversity, ecological along with the watershed issues of the river basin and its tributaries.
- Fish and other biodiversity: Desk review of published articles and reports, and preliminary field study will be conducted to prepare a checklist of aquatic biodiversity, especially focusing on major keystone fish species and other important fauna and flora in the river basin and the tributaries. Further, information on several issues on aquatic biodiversity conservation, major threats to the fish population, etc., will also be collected.
- Socio-economic information: Household survey, focus group discussion and key informant survey will be conducted to collect information about the social and economic status of the local communities, living in the river basin and its tributaries.
- Land use and land cover map: GIS map of a proposed river basin and its tributaries with recent land use land cover data (available from the government of Nepal) will be prepared using either ArcGIS or QGIS.

Step II. Feasibility assessment of potential hotspots

After identification of potential hotspots, their viability in terms of biophysical, environmental, technical, legal, socio-economic conditions, etc. will be assessed.

Desk study

A desk study will be conducted to collect information related to the existing legal framework, governance system and gather the scientific data on biological, and aquatic diversity in fresh water and river systems to identify the potential fish sanctuary area. The required data and specific information will be acquired through various relevant sources, which will either be published reports from the government or project reports related to aquatic biodiversity conservation, biodiversity, use of freshwater, wetlands, national parks, and related legal frameworks. These collected data will be:

Spatial information: The latest available GIS maps of the watershed, illustrating the river drainage, land use, administrative boundary of municipalities, sub-watershed, settlement distribution, and elevation, will be collected. Satellite image/aerial photographs as well as maps from different agencies, and municipality offices will be collected to update the base map. Google image can be used to delineate the existing land use.

Scientific data of flora and fauna diversity: The scientific data about the diversity of flora and fauna in the watershed area, freshwater quality, and the diversity of the aquatic habitat, will be collected. Besides habitat quality such as hydrology, water depth, seasonal fluctuation, stream/river bed substrate, etc., that are the bases of the fish sanctuary declaration protocol will also be documented.

Socio-economic data and information: Municipal records or archives and published reports, including CBS data, are the important sources of information related to socio-economic, municipal revenue and expenditure, development budgets, plans and programs, demography, particularly with estimated beneficiaries. Similarly, different line agencies and partner organizations working in the municipality will provide information about physical and social municipal infrastructures in and around the proposed fish sanctuary areas.

Socio-cultural and religious values: Cultural or religious values of the river stretch will be documented by consulting local stakeholders.

Field study

The team of experts comprising Zoologist/Fisheries Biologist, Botanist, Sociologist, Economist, GIS Analyst, Data Analyst and Governance expert,

led by the team leader will conduct the field study. The potential aquatic conservation site, identified from the desk study, will be verified in the field by addressing the feedback received from the community, political representative, and municipal administration.

The team will also conduct the reconnaissance survey, interviews, meetings, and small group discussions with local communities and line agencies and validate the collected maps. The potential risks, problems, and issues at the municipal, as well as ward level, will be thoroughly identified by several workshops and meetings on the local level. The specific communities, which need to have separate consultation, will be identified in this phase. Few features of the field study are discussed below:

Reconnaissance survey

The survey will be done to validate the secondary information, get stakeholder's consent and enrich the knowledge with challenging issues. The team will undertake a field survey of the existing alignment, providing higher priority on existing corridors. The fieldwork for alternative options will include reconnaissance surveys (drive along at existing roads and walk over along the suggested options), socio-economic data collection, and an initial review of the relevant environmental factors and mapping the affected socio-environmental assets.

Simultaneously, social and environmental groups will conduct reconnaissance to assemble data, identify potential problems, and collect feedback and suggestions. The team will attempt to identify the vulnerable groups whose social, economic, or environmental capability could be threatened either by the construction work or land acquisition. A walkover survey of all alternatives will also be carried out by a team of experts/specialists, to identify the location of topographical difficulties such as cliffs and gorges, drainage management difficulties due to their location (seeping slopes, irrigation channels), slope steepness, and visible limiting slope angles in the vicinity, type of rocks, current land use pattern and its effect on the proposed fish sanctuary. Similarly, existing landslides and other unstable slopes including matching mitigation treatment, gully erosion, and debris flow areas, likely foundation condition for major structures, construction materials, and environmental and socio-economic considerations will be observed. The reconnaissance field investigations will be carried systematically and consistently by preparing simple standard field

data sheets to include all the above-mentioned factors in a single page, so that objective notes can be prepared directly on the sheets. The standard field data sheet ensures that all required data are collected adequately in a consistent manner to allow conceptual design including indicative quantity and cost estimation of the different options.

Topographical survey

The touristic trekking routes famous for adventure and scenic beauty may follow challenging topography, which may not be easily accessible for the team of experts. In that case, for convenience and to get a better knowledge of topography and a bird's eye view of the whole route, the team will conduct aerial surveys, based on various features, such as collecting geometrics or other imagery. The team will further collect data on the characteristics of the land and its altitude through a topographic survey.

Social assessment

Social Assessment (SA) will be carried out adopting an analytical method and participatory process that uses a range of open-ended, semi-structured, and closed data collection techniques to identify the impacts of the fish sanctuary on different stakeholder groups. This assessment will help in identifying the prevailing structural reason for poverty and social diversity, reflecting gender, ethnic and indigenous factors that incorporate the vulnerability of the groups. This process will also identify and prioritize critical social and economic issues and address them in the design and implementation phases of the fish sanctuary with the intent of poverty reduction.

The collected social data will be analyzed to understand the social dimensions of the target population to be incorporated in the designated fish sanctuary area, addressing poverty reduction. The baseline data will be collected at the beginning of the fish sanctuary declaration, which will greatly help in the operation. The consideration of analysis includes beneficiaries population parameters; prepare to socio-economic profiles of sub-groups within the affected population, assess the needs of the beneficiaries, the capacity, and skill of the community, gender issues, vulnerable groups due to involuntary resettlement, and formulate appropriate measures to avoid, mitigate or compensate the adverse impacts in consultation with these groups and active participation of the indigenous people. All the issues will be analyzed using standard statistical and analytical methods. The approved questionnaire and

other tools for data collection will be used to determine the socio-economic condition. The collected data and information will help in performing the SWOT analysis of different options and finally end up with the best-suited option.

Biological assessment

Fish and aquatic animal survey

The primary source of data will be based on the fish collected from rivers, direct field observations, and key informant interviews. Fish sampling will be done using cast nets, loop-line, and hook-line. Hand cast net with the length and breadth of 2m X 2m, and hole (mesh) size of 2.5cm X 2.5cm will be used (Shrestha et al., 1994; Sharma and Jha, 2012) during the survey. Similarly, benthic macroinvertebrates will also be collected from the sampling sites. Stations for sampling fish and macroinvertebrates will be selected, in the confluence of major tributaries.

Aquatic floral assessment

Field surveys will be conducted in the potential river stretch, to understand the present status of vegetation including population density, regeneration status, and identification of important species. A transect or circular plots will be made, across certain well-defined ranges, within the proposed sites, to record the presence of local flora of different categories including medicinal, aromatic, ornamental, ecosystem maintenance, and environmental importance during the field survey. Ground/terrestrial flora will be identified during the field survey and unidentified species will be later identified in the National Herbarium with the help of standard literature (Stainton, 1988).

Wild animal assessment

A field survey will be conducted at the potential habitats of wild animals to find their present status, regarding population density, associated species threat status, etc. The assessment applies scientific methods such as transect walk survey, acoustics survey, camera trapping, etc., to record the presence of local wildlife across well-defined ranges within the potential sites. Primary data on the wildlife will be collected by direct observation (sighting and counting methods) and indirect observation such as measuring pugmarks, counting droppings/pallets, etc. Furthermore, data from the field will be compared

with the secondary sources and the species will be tallied with the list of endangered and protected species of Nepal. The existing literature, reports, and investigations on the fauna will be carefully reviewed. Information provided by locals will be valued and incorporated after authentication.

Aquatic bird survey

Standard common bird survey methodology will be followed during an aquatic bird survey, in which an observer walks on a route within 50m of every point of the survey area, identifies species, and observe the activity of birds (Grimmet et al., 2003). The types of observations included birdsong, alarm calls, courtship, aggressive displays, carrying nest material, food carrying, family groups, and feeding young. A vantage point survey will also be used, where birds flying over the survey area and potential boundaries will be noted.

Step III. Stakeholder consultation

The success of the establishment of a fish sanctuary will depend on the interest and support the stakeholders including local people, community groups, government agencies, and non-governmental organizations. Meetings, interviews, seminars, and workshops will be organized in presence of stakeholders from the selected sites to understand their interest, perception, attitude, and expectation toward the fish sanctuary (annex 2-4).

Step IV. Proposal preparation

A final proposal will be prepared that explains the objective and necessity of fish sanctuary in the region and its significance, and details on proposed or selected river stretch for the sanctuary establishment. It also includes socio-economic, biophysical, and feasibility assessment, major threats to the biological resources, along with the proposed conservation measures. Similarly, the proposal addresses the legal, institutional, and policy framework, monitoring and evaluation framework, and sustainable management approaches of the sanctuary (operational plan, management plan, and conservation strategy).

Step V. Brief Environmental Study submission for fish sanctuary declaration

After meeting all the requirements, a brief environmental study report will be submitted to the government of Nepal for final approval and declaration of a fish sanctuary in proposed river stretches.

2. Proposed river stretches

2.1 Karnali River Basin

The Karnali River, one of the most significant Trans-boundary rivers systems of the Himalaya and the longest river in Nepal, flows through the Mt. Kailash in Tibetan Plateau, dissecting the high Himalaya of Western Nepal and covering nearly 1080 km in length and more than 900 km^2 watershed areas before congregating with Ganges River in India (Bennett, 2020). It links to numerous rain and snow-fed tributaries, including the Mugu Karnali, Humla Karnali, Thuli Bheri, Kawari, Thuli, and West Seti. The Humla Karnali originates in Tibet and meets Mugu Karnali at Galwa, forming the Karnali River. The basin has a tropical monsoon climate, characterized by year-long warm temperatures, small annual temperature variation, and high rates of precipitation from May/June to October. It receives about 80% of precipitation during the summer monsoon (Khatiwada et al., 2016), while the region suffers winter drought frequently in many areas. The average annual precipitation of the basin is about 1479 mm (Khatiwada et al., 2016) and the mean annual flow is about 1392 m^3/s at Chisapani.

The numerous tributaries and wetlands of the Karnali River Basin support rich aquatic biodiversity; about 128 taxa of macroinvertebrates belonging to 84 families and 22 orders (Shah et al., 2020), 121 species of fish, more than 50 species of riparian birds, 13 species of aquatic reptiles and 4 species of aquatic mammals (Smith et al., 1996). Most of the fish species are found in the Middle Karnali, however, their movement varies accordingly during breeding and rearing seasons (Smith et al., 1996; Sharma et al., 2020). About 46 different species of fish in the landscape use the upper and middle portion of the Karnali River and its tributaries for breeding grounds (ADB, 2018). Of these fish species, a few are considered endangered such as the common snowtrout, *Schizothorax richardsonii*, the Himalayan mahseer, and *Tor putitora*. Besides, it is also home to endangered species such as the Ganges river dolphin, *Platanista gangetica*, the gharial, *Gavialis gangeticus*, the smooth Indian otter, *Lutra perspicillata*, and migratory fish like the Indian mottled eel, *Anguilla bengalensis*, and the dwarf gonch, *Bagarius yarrelli*.

2.2 Site selection

After identifying potential hotspots and their feasibility assessment, three areas of Karnali River Basin (Rakam/Middle Karnali, West Seti Karnali, and Thuligaad Karnali) were considered suitable for the establishment of the fish sanctuary (Figure 1). A brief profile of each watershed area is described below.

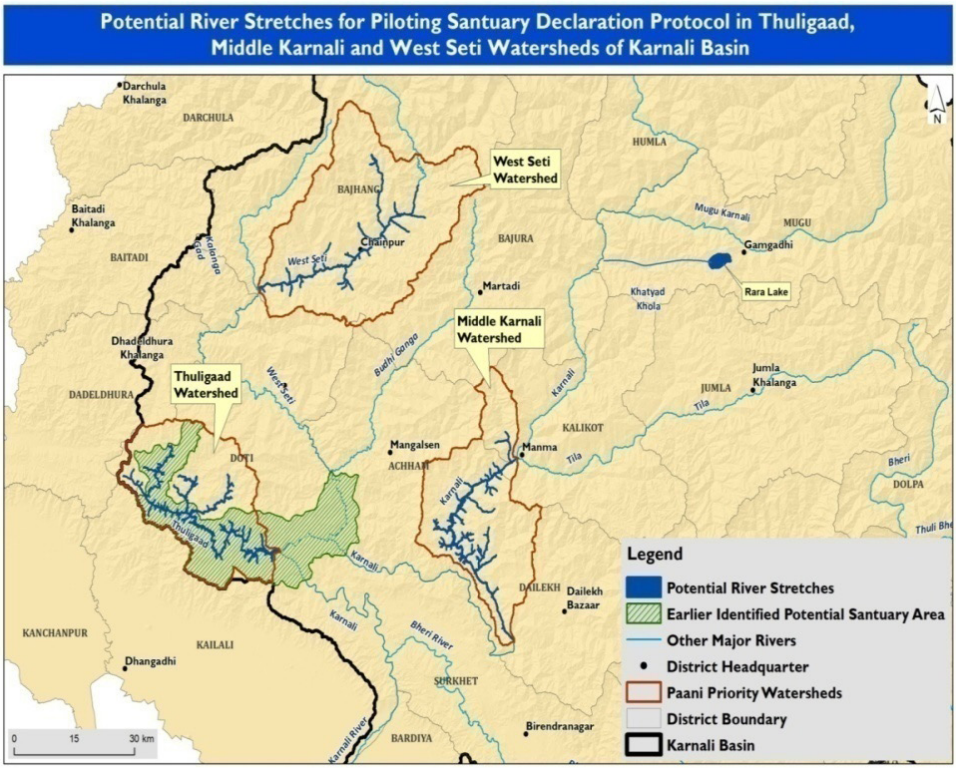

Figure 1. Potential river stretch for the establishment of a fish sanctuary in the Karnali River Basin.

(Source: USAID Paani Program)

A. Fish Sanctuary for Mahseer Conservation in Middle Karnali

Biophysical status

The Middle Karnali watershed contributes 67.7 kilometers to the Karnali River, from the junction of Humla Karnali and Tila rivers at Jitegada downstream to the junction with Lahore Khola at Tallo Dugeshwar. The river bed is primarily covered with boulders in the north and sand in the south, with a high sediment load. It has numerous small tributaries such as Lodegaad, Chiltagaad, Bhanakotgaad, Khulagaad, Talagaad, Pulum Khola, Thote Khola, Amina Khola, and Mahana Khola, spread throughout the watershed covering a total of 659 km waterways. Within Middle Karnali, there are 33 sub-watersheds: 17 are located in Achham, 15 in Dailekh, and only one in Kalikot (Annex 1). About 73 percent of the watersheds are moderately inclined, 15% gentle slope and 11% are steep. The maximum water discharge from Middle Karnali is 891253 liters/second during the peak monsoon period (August) and the minimum is 81515 liters/second in the peak dry period (January) (USAID Paani, 2017).

Forest in Middle Karnali covers about 52% of the total land, followed by 30% agricultural land, 13% pasture and grazing land, and the remaining 5% water bodies. The forest is dominated by Chir pine and hilly broadleaved trees in the northern part, whereas, Chir pine and mixed Sal forest in the southern part. Other important forest species include *Alder*, *Rhododendron*, *Quercus*, and Kharsyu. Forests in Middle Karnali also offer numerous non-timber forest products such as Timur (*Szechuan pepper*), Rittha (Soap nut), Aamala (Goose berries), Khoto (resin), Lokta, etc. (USAID Paani, 2017).

The average annual rainfall of Middle Karnali is 1293 mm, of which in the dry season (November– April) it is about 34 mm and 237mm in the wet season (May-October). Spatially, average annual rainfall increases in the western part of the watershed (+10mm/year) and decreases in the eastern part (-10mm/year). The highest monthly average maximum temperature is 26°C, while the minimum is 9.05°C. In the watershed, winter and spring temperatures are increasing at a rate of 0.03°C/year, while in summer (monsoon) the rate of increase is at 0.02°C/year (USAID Paani, 2017).

Many fish species found in the entire Karnali River are available in Middle Karnali. Around 46 different species of fish use Middle Karnali and its tributaries for several purposes such as breeding, rearing, rest, migration

route, and feeding. Of the fish species, few are considered endangered; the common snow trout, *Schizothorax richardsonii*, and the Himalayan Mahseer, *Tor putitora*. It is also home to rare migratory fish like the Indian mottled eel, *Anguilla bengalensis*, and the dwarf gonch, *Bagarius yarrelli*. Upstream fish migration generally starts when discharge increases in May and June after pre-monsoon rains whereas, downstream migration starts when discharge decreases in September and October after the post-monsoon. The population of about 39 species of fish is currently decreasing (USAID Paani, 2017). Middle Karnali is also under pressure by several invasive plant species such as West Indian Lantana *Lantana camera*, Santa Maria feverfew *Parthenium hysterophorus*, and Siam weed *Chromolaena odorata* but aquatic invasive species are absent. Besides it, overfishing, fish nursing and fish spawning areas are assessed in the middle Karnali by USAID Paani Program (Figure 2).

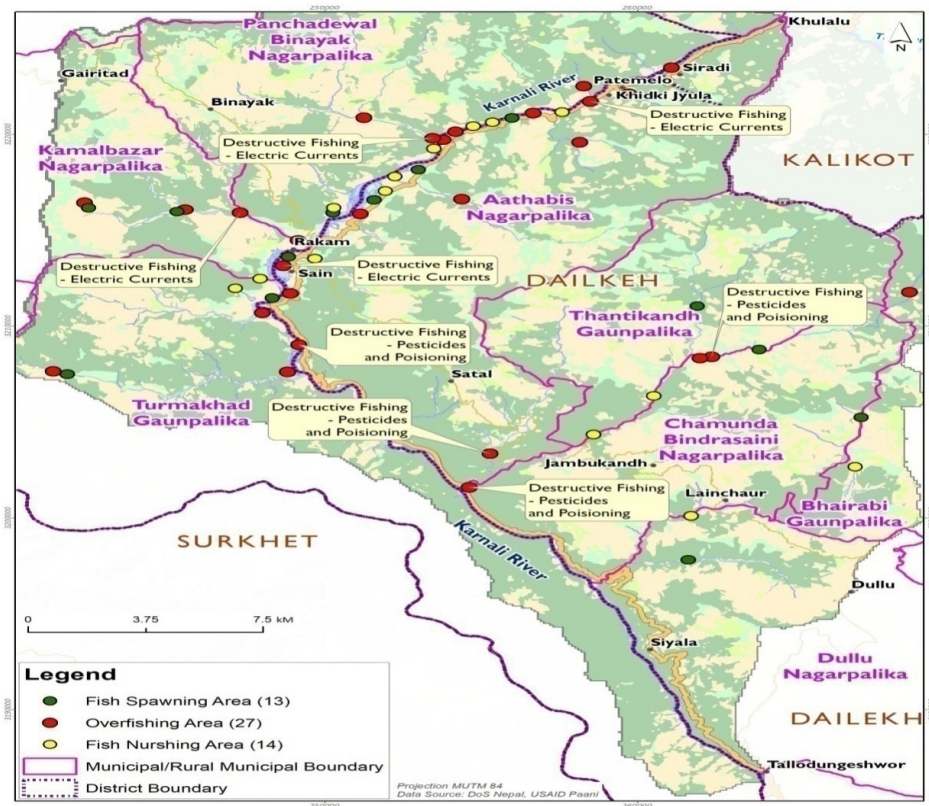

Figure 2 . Mapping of fish vulnerability assessment of Middle Karnali watershed

(Source: USAID Paani Program)

Socio-economic status

The total population of the Middle Karnali watershed is 171856, of which 59% is Brahmin/Chhetri/Thakuri, 30% Dalit, and 3% Janajati (70% are Tharu, living in the southern reaches of the watershed). Agriculture is the primary source of income (70% households) followed by livestock rearing (12% households), service-based occupations (4% households), remittance (3.5% households), and wage employment (3% households) whereas, the remaining 8% of income sources comprise of fishing, poultry farming, and dairy farming. Seasonal migration and abroad work is increasing rapidly in the watershed, primarily for men. A total of 1587 traditional people from seven different traditional communities; Majhi (36%), Badi (27%), Kumal (26%), Tharu (9%), Rajbhar (1%), Nuniya (1%), and Sonar (1%), are residing within the watershed area.

Capture fisheries are becoming an increasingly important source of income as the commercial fishing industries are developing. Many fish markets are available within the watershed, of which most are located along the Karnali Highway, including Tallo Dungeshwor, Rakam Karnali, Khidkijyula and Hulma Bazaar. These areas supply fish to local hotels and restaurants in the region. Capture fisheries have provided another attractive livelihood option for households that are struggling with agriculture and/or other occupations. Fish farming ponds are becoming increasingly common in the watershed; for example, in Rakam, 32 fish ponds now operational, cultivating mainly Mangur fish. Economically important fish species in the watershed are Snow trout, Mahseer, and Bajelo, which hold high significance among local fisheries communities.

The major seasonal crops cultivated in the watershed include rice, millet, wheat, maize, and potato. Livestock, commonly goats, cattle, and buffalo, also play an integral role in the local farming system. However, food security due to drought and underproduction is a matter of great concern. Almost half of the households in the watershed grow crops with only three months of food security to support their families, of which, 65% of those households are from Dalit and 30% Janajati communities (USAID Paani, 2017).

Although there are government and financial institutions in a few household-dominated areas, only 19% of households have a bank account, and most areas devoid of banking and financial facilities (USAID Paani, 2017).

B. Fish Sanctuary for Asala Conservation in West Seti

Biophysical status

West Seti River is an important tributary of the Karnali River Basin that originates from the snowfields and glaciers around the twin peaks, Api and Nampa, in the south-facing slopes of the Himalayas and drains towards western Nepal. Almost the entire portion of the watershed lies inside the Bajhang district (97%), with the remaining 3% extending to Doti and Bajura. It extends from 750m to 3400 m elevation, covering an area of 1488 km^2. The watershed contains 151rivers and streams in total, and seven sub-watersheds with a combined total drainage density of 647 m^3 and drainage length of 963 km, as many rivers of the watershed flow southward and mix with the Karnali River. Major rivers of the watershed include Kalanga Khola, Bauligaad, Tarugaad, Sunigaad, Talkotgaad, Thalairgaad, Jadarigaad, Bhayagutegaad, and Listigaad. It has plenty of lakes such as Dau Lake, Timadaha, Khaptad Tal, Lokunddaha, and Khapardaha. Dau Lake, located at 2233 meters near Surma Rural Municipality is an important lake in the watershed, which provides water for domestic and agricultural needs (USAID Paani, 2019).

Most of the area in the watershed is covered with forest and shrubland (51% of the land), followed by agricultural land (20%), grazing land or pasture (15%), barren land (13%), and rivers and streams (2%). Most of the settlements in the watershed inhabit the plains along the Seti River, between 750 m and 2,500 m elevation. The forest is the primary natural resource of the area, providing timber and numerous non-timber forest products such as medicinal and aromatic plants. Forest is dominated by mixed hardwoods (53%), followed by Banjh oak (20%), Pine (18%), Fir (4%), Deodar cedar (3%), and a limited portion of Sal and Sisau (1% each) in lower elevational regions (USAID Paani, 2019).

The average annual rainfall received by the West Seti watershed area is 1800mm, of which maximum rain occurs during July (1480 mm) i.e., monsoon season, and minimum during December (64mm) i.e., post-monsoon season. In the monsoon season, rainfall is increasing at the rate of 10mm/year, whereas in post-monsoon, it is decreasing at the rate of 2 mm/year. The maximum and minimum mean monthly temperature in the watershed varies

from 4°C to 19°C in winter and 19°C to 32°C in summer (USAID Paani, 2019).

The West Seti watershed provides diverse habitats for aquatic and terrestrial species among its various ecological zones. The Khaptad National Park along the southern border offers sanctuary to a large diversity of floral species (567) and fauna, including 217 bird species, 13 species of fish, several mammals, and reptiles. Thirteen species of fish have been identified in the watershed, and the major species include Asala *Schizothorax* sp., Kathyal *Acrossocheilus hexagonolepis*, and Sahar *Tor* sp. Matangulu et al. (2017) documented a total of 34 families and 7 orders of macroinvertebrates in the West Seti River. Some of the common tree species in the watershed include Chir pine, spruce, fir, maple, bird, alder, and rhododendron. Dense stands of bamboo and several medicinal herbs such as Bojho *Acorus calamus*, Chutro *Berberis* sp., Eklevir *Lobelia pyramidalis,* and Bhojpatra *Betula utilis*, are cultivated either for personal use or sale (USAID Paani, 2019). It has also identified the fish spawning, over fishing and fish nursing areas in the West Seti River under USAID Paani program (Figure 3).

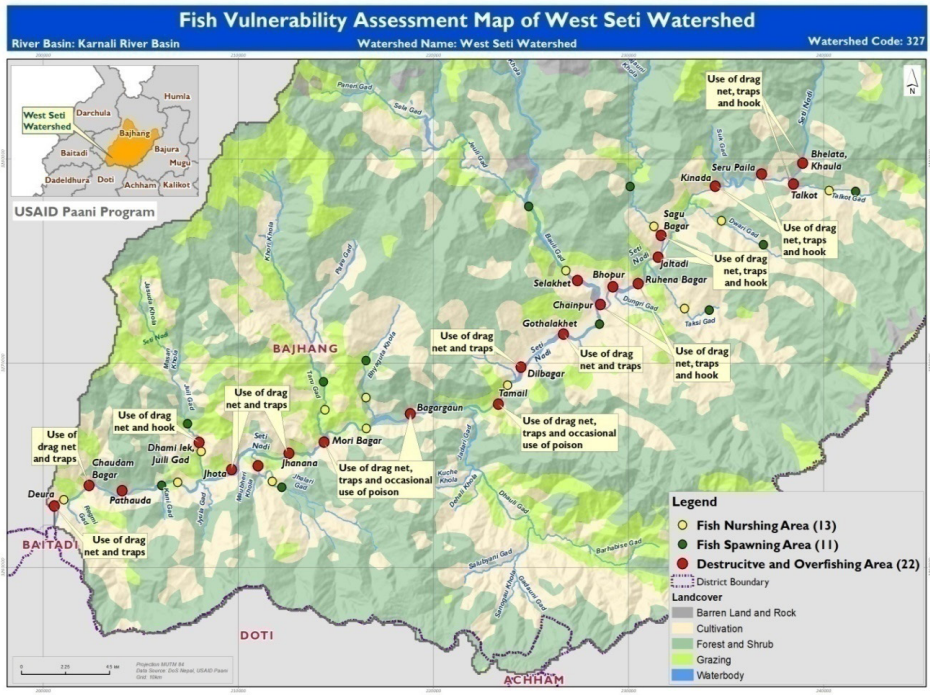

Figure 3. Mapping of fish vulnerability assessment of West Seti watershed (Source: USAID Paani Program)

Socio-economic status

The total population of the watershed is 130593, of which 53% are female and 47% are male. The majority of the population is of Brahmin/Chhetri/Thakuri/Sanyasi (72.7%), followed by 20.8% of Dalit, and the remainder as both Janajati and indigenous (6.5%). The population density of the watershed is 88people/km^2. Agriculture is the primary subsistence in the watershed, which consists of 83.9% households, followed by wage labor (4% households), traditional occupations, such as blacksmithing (3.3% households), and service jobs (2.8% households). The river basin has a total of 28240 hectares of cultivated land, of which approximately 35.3% is irrigated, however, in terms of households, only 41% have access to irrigation (USAID Paani, 2019).

Fishing is also one of the most important sources of income in the river basin. Local communities use a mix of traditional and non-traditional methods to capture fish, many fishermen still prefer traditional tools such as gill nets, fishing hooks, and casting. However, the increasing market demand for fish has inspired some people to adopt more harmful practices such as explosives and electric current. Fishermen usually capture a maximum of up to 2 kg of fishes per day and about 190 kg per year. About 62% of households reported that fish stocks have decreased over the past decade, alongside a decrease in fish species number. They strongly believe that such a decrease is due to a rise in the number of new fishermen, increased use of pesticides and electric current, increased use of small mesh nets, changes in fish habitats due to landslides and solid waste disposal, and hydropower projects, restricting the water flow.

Major cultivation crops in the area vary along elevation but common crops include maize, millet, barley, wheat, potatoes, lentils, and soybean. The land alongside the rivers is highly productive, however, like in Middle Karnali, food security remains a major challenge in the watershed, as nearly 80% of families lack food reserves beyond six months.

Regular use of banking and financial institutions in the watershed is increasing since about 46.1% of households held bank account. However, this number is lower for Dalit families and the reason for not having a bank account is lack of money and long - distance travel to banks.

C. Fish Sanctuary for Asala Conservation in Thuligad Karnali

Biophysical status

The Thuligad watershed area is also one of the most significant river systems in the Karnali River Basin, which stretches across the Jorayal and Baddikedar rural municipalities in Doti district, and the Chure and Mohanyal rural municipalities in Kailali district. It is composed of 17 major river streams with 156 small tributaries covering a total area of 879 km². The average discharge of the river is around 3517 liters/second, however, unlike Middle Karnali and West Seti River, discharge decreases during pre-monsoon, monsoon, and post-monsoon but increases in the winter season. The watershed has four freshwater lakes; Brahm, Jwalaban, Rakxes, and Chhatiwan, which harbor suitable habitats for aquatic biodiversity and possess great significance for the livelihood of riverine households.

Most of the area in the Thuligad watershed area is covered by forest (78%) followed by agricultural and pasture land (19%), other woodlands (1%), and shrubland (0.3%). The rivers and streams account for a total of 17 km^2land, which comprises 2% of the total watershed area. The forested area is primarily mixed hardwoods (43%) and pine (37%). The resin from Chir Pine is massively harvested for industrial use. The forest patches are dominant in Chhatiwan, Laxminagar, Sahajpur, Nigali, and Mohanyal.

The mean annual rainfall recorded in the watershed is 1122 mm, of which more than 80% falls during the monsoon. In the dry season of November to April, the average monthly rainfall is 94 mm/month. In the western part, annual rainfall is decreasing (-10 mm/year) but increasing in the eastern region (10 mm/year) (USAID Paani, 2018). Likewise, the mean monthly temperature in the river basin ranges from 15°C in winter to 31°C in summer.

Since the watershed has four freshwater lakes, they are important habitats for fish and migratory birds. Although data on biodiversity in the Thuligaad watershed is scarce, there is a confirmed record of 17 wildlife species of national and global importance, including 27 species of fish, 9 species

of reptiles, 20 species of birds, and 16 species of aquatic vegetation. The economically important fish species in the river basin are Sahar *Tor putitora*, Asala *Amblypharyngodon microlepis*, Kathyal *Pseudecheneis sulcata*, etc. Dominant vegetation in the watershed are pine (*Pinus roxburgii)*, and Sal (*Shorea robusta)* in the lower elevation, and *Quercus* sp. in the higher elevations (USAID Paani, 2018).

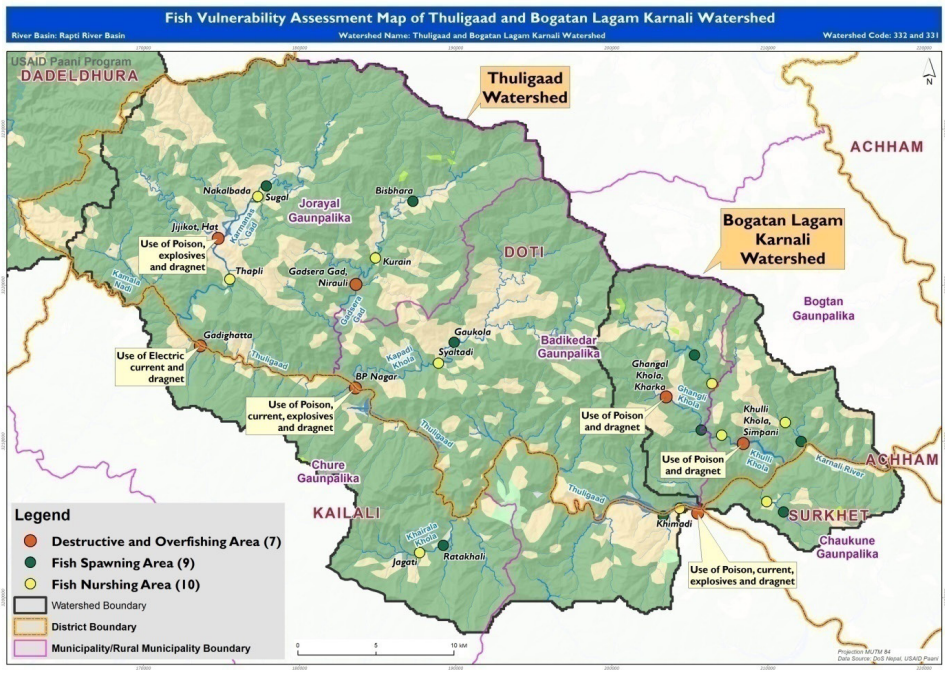

Figure 4. Mapping of fish vulnerability assessment of Thuligaad watershed

(Source: USAID Paani Program)

Socio-economic status

The total estimated population of the Thuligaad watershed is 42227, which is evenly distributed between male and female. The population density of the area is low (56 people/km^2), and is mainly concentrated in small urban settlements such as Gairabazar, Budar, Laxmingar, Saraswotinagar, Bipinagar, and Mannakapadi. Demographically, 59% of the population is Brahmin/ Chhetri/Thakuri, 24% are Janajati, and 17% are Dalit (USAID Paani, 2018).

The main sources of income are fishing, agriculture, and livestock herding. They also use traditional methods for fish hunting, but due to the recent market value and increasing demand for fish, destructive methods for fishing by using electrical current, gill nets, and draining water in rivers are posing serious threats. Harvested fish are only sufficient for meeting local market demands in Bipinagar, Laxminagar, Gadsera, and Sahajpur. People are aware that fish stock and species richness have declined over the past few years. Major seasonal crops in the agricultural land include rice, millet, maize, wheat, barley, buckwheat, mustard, potato, tobacco, lentil, beans, soybeans, and sugarcane. Although the majority of households are involved in agriculture, a large portion is still insufficient to produce year-round food security. Livestock rearing in the watershed includes goat, cattle, and buffalo (USAID Paani, 2018).

In this watershed, there are three commercial banks, four micro-finance services, and 13 cooperatives providing financial assistance to personal and commercial ventures. However, only 22% of households have at least one family member with the bank account; mainly from Brahmin and Chhetri groups, but only a few households of Dali and Janajati groups (USAID Paani Program, 2018).

D. Water quality and invertebrates in Karnali River

The water quality is directly related to the habitat quality of fish and other aquatic animals. The chemical composition of water determines the diversity of aquatic species. Particularly, macroinvertebrate species can be used as ecological indicators (Shah et al., 2020a). The Karnali River contained the lowest chloride and sodium but the highest calcium and phosphate concentrations that indicate a healthy river system for aquatic species (Jenkins et al., 1998). However, the finding was based on two decades ago and within these periods, river systems have altered by natural and anthropogenic factors such as landslides, extraction of river materials, road construction on river banks, waste disposal in the river. The recent researches conducted on water quality and macroinvertebrates found that water quality parameters and macroinvertebrates are diverse in the Karnal river and its tributaries (Table 1). High species diversity was reported in the tributaries than the river main stem. Such high species diversity links to the high habitat heterogeneity and diverse flow types in tributaries which supported variable water quality parameters than the steady main stem. Similarly, The river system was alkaline (pH value ranged from 7.9 to 8.7) but the macroinvertebrate assemblages between the two ecological regions i.e. sub-tropical and temperate zones, and between main steam and river tributaries did not vary significantly in West Seti River, and it's tributary (Matangula et al., 2017). Due to the high level of pollution in tributaries; as out of 10 sites, only one site was categorized as unpolluted, and others were either moderately or very critically polluted, e.g. Ghat Khola was found to be more polluted because of the direct discharge of effluents from the hotels and Chainpur municipality (Shah et al., 2020a). In this site, the dominance of red Chironomids indicates organic pollution (Machado et al., 2015). The composition of macroinvertebrates was also found to be affected by water diversion in headwaters. Shah et al. (2020b) found that the water diversion in the headwaters results in a low abundance of the rheophilic (Trichoptera taxa) whereas, high abundance of non-rheophilic taxa such as Coleoptera, Odonata, and Lepidoptera. Similalry, Suren (1994) studied the effects of altitude and land use on macroinvertebrates communities in the Dolpo region of Nepal found that macroinvertebrates richness declined with increasing altitude; with ten insect families more abundant in lowland streams, and five in alpine streams. The study further concluded that altitude, temperature, stream width, and land use were major factors implicating the invertebrate community structure and water quality.

Table 1. Water quality and macro invertebrates in Karnali River Basin

S.N.	Water quality parameters	Major findings	References
1	pH, water temperature, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen saturation (DO, %), alkalinity, hardness, flow velocity, water depth, discharge	• The tributaries have high habitat heterogeneity and diverse flow types, which resulted in increased taxonomic richness and abundance in the tributaries compared to the river's main stem. • A total of 128 taxa of macroinvertebrates belonging to 84 families and 22 orders were recorded in the study sites of the Karnali River Basin.	Shah et al., 2020a
2	pH, water temperature, conductivity, total dissolved solids (TDS), and dissolved oxygen saturation (%)	• Temporal change in river discharge accompanied by consistent water abstraction is a strong driver of benthic macroinvertebrate assemblage structure, including trait composition. • Water abstraction < 80% of the driest period (baseflow) of the year does not seem to influence benthic macroinvertebrates diversity and abundances in headwaters of the Himalaya under least hydro-morphological changes and pollution status in the rivers.	Shah et al., 2020b
3	pH, temperature, DO, Nitrate, Total Phosphate, and Ammonia-N	• A total of 1666 individuals belonging to 34 Families and 7 Orders of macro-invertebrates were recorded.	Matangulu et al., 2017
4	Temperature, conductivity, width	• 138 macroinvertebrate taxa were recorded	Suren, 1994

3. Basics of determination of conservation status, threats to biological resources and conservation measures

3.1 Dam construction and water diversion

Threats

Although Karnali River Basin lacks large-scale hydropower dams and irrigation channels, numerous microscale hydropower plants are distributed throughout the river basin. All of the three proposed watershed areas are facing pressure from microscale dam construction and water diversion for rural irrigation. In Thuligaad, there are 7 functional hydropower and few irrigation channels, the West Seti has 8 hydropowers and 65 schemed irrigation channels, and the Middle Karnali is also full of numerous hydropower and irrigation channels. Besides, in two anticipated watersheds, large-scale hydropower of 750 MW in West Seti River and 900 MW in Middle Karnali is proposed. As each watershed harbors suitable habitat for endangered fish species, these species use the upper portion of the watershed and its tributaries for breeding sites, construction of dams is ceasing their movement and largely impacting their populations (ADB, 2018; Shrestha and Yadav, 2019). As these watersheds are also a migratory route for many species of fish, water diversion is reducing water quantity and velocity, which hampers fish migration.

Conservation measures

Most of the hydropower was constructed without conducting EIA; the first step will be to check whether these projects are hampering river ecosystems or not. If they are significantly deteriorating the river ecology, the best thing to do is to forbid such projects. EIA should mandatory for each hydropower developmental project in the future. Similarly, for irrigation channels, high amounts of water diversion from the mainstream should be prohibited. The minimum volume of water required for the natural activities of each aquatic species should be identified and maintained throughout the year.

3.2 Construction of roads and resultant landslides, soil erosion and sedimentation

Threats

Haphazard road construction in watershed area is a burning issue. Throughout the watershed areas, there are several newly constructed road networks without a proper drainage system. Road building is given high priority throughout the watershed areas and is a common first promise of the major political parties. As these watershed areas receive a large amount of rainfall during the monsoon season, such constructed roads are further aiding in roadside landslides and soil erosion, which increases sedimentation in the rivers. Thus, sedimentation is degrading the aquatic ecosystem through unwanted nutrient supply and causing an imbalance in water quality parameters.

Conservation measures

The adverse impact of such constructed roads can be minimized by applying environment-friendly and cost-efficient bioengineering techniques to reduce landslide and soil erosion. Haphazard road construction in all watershed areas shall be prohibited and compulsion of EIA in each road construction project shall be enforced. The areas facing massive landslide and soil erosion shall be planted with resistive vegetation such as bamboo, broom grass, etc. Monitoring of sediment collection in each river system shall be done regularly and when sediment collection is unbearable, extraction shall be made without hampering aquatic ecosystems.

3.3 Gravel mining and extraction of river resources

Threats

Gravel mining is also one of the major threats in the proposed watershed areas. In Thuligaad there are four major operational mining sites i.e. Laxminagar, Kamalanadi, Bipinagar, and Kapadigaad. The gravel extraction in the West Seti River and Middle Karnali (in Tallo Dhungeshwor) are also popular. Sometimes gravel extraction may be necessary especially during the monsoon period to reduce riverbeds, however, over-extraction in other seasons can be detrimental for aquatic species. Likewise, overfishing with the use of destructive fishing techniques and over-extraction of logs from the

river and banks are also prominent in the proposed watershed areas. Many aquatic species prefer sands, bounders, and logs for survival and the over-extraction hampers their life cycle, for example, riparian birds lay their eggs on sand, freshwater fishes use tree logs and boulders in the river as shelter, breeding and rearing site, and reptiles use sand and boulders for basking and laying eggs (Smith et al., 1996).

Conservation measures

Most of the gravel mining projects are found running without conducting EIA; the first step will be to identify whether these extraction activities are hampering river ecosystems or not. If they are significantly deteriorating the river-bed structure, then mining activities should be forbidden. The compulsion of EIA in future mining projects should be enforced. Likewise, the extraction of fish using electric current, boulders, and logs from the river should be banned. Extraction of gravel from the areas having high gravel density should be allowed only after careful initial environmental examination. To minimize overfishing, the establishment of fish ponds should be promoted, providing certain amounts of financial aid and sustainable fishing practices in the river system shall be formulated.

3.4 Water pollution and solid waste disposal

Threats

For many years, the water quality of these river systems was pristine due to low population pressure and reliance on organic and sustainable farming practices. However, as the population has increased and urbanization has brought modern goods and farming inputs to the watershed, many local governments have been caught off-guard in devising plans and infrastructure to handle rising solid waste (e.g. garbage and plastics). Household-level solid waste management is troubling as the majority of people dump the solid waste in open landfills and directly into the rivers. Major pollution points in the Thuligaad watershed include Budar, Sahajpur, Bipinagar, Gaira, Bhatkada, Khanidanda, Jorayal, Khimadi, Mohanyal, and Nigali, in the West Seti include Deuda, Tamail, Chainpur and Bhopur and in the Middle Karnali, pollution points include Tunibagar, Rakam Karnali, Ramagaad, Paduka, and Khidkijyula. Thus, the pollution is hampering river ecosystems by changing benthic macroinvertebrates and aquatic fish composition.

Conservation measures

Solid waste management awareness campaigns shall be organized, from household to community level in major pollution points of each watershed area. Environmental friendly solid waste management training (reduce, reuse, and recycle) shall be given to each household, hotel, and industry, alongside donating dustbins and organizing community-level river cleaning campaigns. People shall also be encouraged to use organic fertilizers, mulching practices, and rotation cultivation in agricultural lands, to minimize the use of harmful pesticides and insecticides, hence reduce agricultural pollutants.

3.5 Forest degradation and drying of water resources

Threats

Despite the majority of areas in each watershed being covered with forest, forest degradation due to the increasing rate of wildfires, especially in dry seasons is a major issue in the region. Though some portion of the forest is managed by community users groups under community forestry practices, unsustainable harvesting technique such as over collection of resin, litter, and firewood, massive logging waste from timber felling, forest road network expansion for timber storage and transportation, etc., and overgrazing are common in the area. These practices are degrading forest health and creating suitable conditions for a forest fire, including the drying of water resources, which lead to forest landslide and soil erosion around the river banks. Forest degradation is also one of the major factors contributing to the increase of sedimentation in the rivers.

Conservation measures

Community forestry groups of each watershed area shall be guided and trained for sustainable harvesting techniques of resin, litter, firewood, and timber using modern harvesting equipment. Expansion of forest road networks will be prohibited and if necessary, the EIA of such roads will be enforced. Community groups will also be trained for sustainable transportation and storage techniques for harvested forest products. Sometimes grazing and forest fire are necessary to maintain forest health hence; forest lines will be constructed in each community forest and seasonal rotational controlled grazing will be applied. For highly grazed, landslide-prone and eroded areas, plantation of local species will be done with the assistance of bioengineering techniques.

4. Legal, institutional and policy framework

4.1 Legal provisions

The legal provisions related to the establishment of a fish sanctuary are closely related under the National Parks and Wildlife Conservation Act, 2029 (1973). The fish sanctuary falls under the type of protected area hence, according to NPWC 1973, if deemed necessary, the government can declare an area as a protected area by publishing a notice in the Nepal Gazette and indicating the clear boundary. Local governments have already enacted aquatic animal and aquatic biodiversity conservation related act in Karnali River Basin. Taking into account the lack of protected areas specially designated to protect keystone fish species in the country and the Karnali River Basin which is home to several endangered freshwater fish species, and highly threatened by several anthropogenic activities; this provision will be a suitable lawful right for the establishment of a fish sanctuary in the Karnali River Basin.

4.2 Institutional framework

Nepal lacks the adoption of the fish sanctuary, so there is no official institutional framework so far. However, as the sanctuary will protect aquatic fauna in their natural river systems, it will be managed under both, a whole watershed/sub-watershed and wetland management systems. The Ministry of Forests and Environment will be the focal ministry in support of the Ministry of Energy, Water Resources and Irrigation, and the Ministry of Agriculture & Livestock. Likewise, as fish sanctuary falls under the protected area regime, the Department of National Parks and Wildlife Conservation will be the Fish Sanctuary Administrative Authority with other supporting departments, such as the Department of Forests and Soil Conservation, Department of Environment, Department of Agriculture, Department of Livestock Services, Department of Water Resources and Irrigation, and Department of Hydrology and Meteorology. The management of the fish sanctuary will also need several actors to accomplish its long-term objectives. The Provincial Ministry of Industry, Tourism, Forests, and Environment will also provide technical and financial resources for management of fish sanctuary within the province. The local government will manage small scale fish sanctuary and involve in conservation. Also, local NGOs, CBOs, Aquatic Animal Conservation Groups, etc. will play a vital role in the Fish Sanctuary Management.

5. Monitoring and evaluation framework

This program will follow the PRISM-Evaluation-Toolkit V1 for monitoring the implemented activities and the evaluation of the program (Dickson et al., 2017). Monthly activities checklist with the required budget amount will be prepared and checked whether all the activities are completed or not within an allocated budget, to monitor both the activities and financial status. Monthly activities may include awareness campaigns in specific watershed areas, stakeholder meetings, workshops, river conservation campaigns, training, etc. Similarly, to evaluate the program the toolkit has formulated five thematic modules; awareness and attitude, capacity development, livelihood and governance, policy, and species habitat management. Each thematic module has methods and guidelines which will be used to evaluate the success during the establishment of a fish sanctuary. For example, some sites of the West Seti River are critically heavily polluted with the Chironomids, is a good indicator of organic pollution and multiple stressors (Machado et al., 2015; Matangulu et al., 2017). This issue falls under the species and habitat management module; and if the use of direct habitat management practices such as reducing direct solid waste disposal in the river, creating awareness campaigns among local peoples, or providing solid waste disposal training to hotels, etc. leads to decrease in abundance of Chironomids and increase in abundance of other benthic macroinvertebrates like Ephemeroptera, Trichoptera, and Diptera (the indicators of pristine water quality) will evaluate the success of the implemented activities and programs in the watershed (Table 2). Awareness and attitude will measure changes in levels of stakeholder awareness and attitudes, and whether such changes lead to altering their behavior that benefits species and river conservation. Capacity development will measure changes in the ability of local people, organizations, or society to perform better, solve problems, or manage their relationships successfully. Livelihood and governance will measure changes concerning people's livelihoods, wellbeing status, and governance arrangements that affect the lives of stakeholders. The policy will measure changes in rules, regulations, and agreements that govern the sanctuary conservation targets.

Table 2. Sample of monitoring and evaluation framework with major objectives of the proposed fish sanctuary, evaluation indicators and methods to archive such indicators

Fish sanctuary's objectives	Indicators	Methods
To enhance fish production	The average number of fish capture per person before and after the establishment of sanctuary	Field observation and fish sampling or Fisherman interviews
To protect the fish from genetic pollution	Healthy population structure of each species	Genetic sampling
	Species expanding distribution range and high genetic diversity	Fish sampling in different river systems/tributaries with genetic sampling
To provide safe breeding and feeding grounds	Healthy river water parameters	Water sampling in breeding and feeding areas
	Suitable habitat characteristics (presence of ample amount of foods, sand, boulders and logs)	Habitat characteristics survey
	Maintenance of minimum river discharge flow	River discharge monitoring
	Low sedimentation rate	Periodic sedimentation survey
To protect breeding and nursery sites and produce vigorous brood fish and enhance fish diversity.	High brood rate	Brood sampling
	Increase in fish diversity over time	Fish composition and diversity assessment (Shannon-Wiener diversity index)
To restore as well as conserve river habitat	Healthy river water parameters	Water sampling in river and tributaries
	Release of minimum river discharge flow	River discharge monitoring
	Low sedimentation rate	Periodic sedimentation survey

To increase the abundance of threatened fish species	Increase capture of threatened species such as *Schizothorax richardsonii* and *Tor putitora*	Fish sampling
To fulfill the demand of fish seed in regenerating population to maintain stock in and around the sanctuary	Increase in demand fish around the sanctuary	Market survey/market preferences survey
	Increase in fish stocks	Brood and stock sampling
To improve the livelihood of local communities.	Increase in household income	Household income survey
To protect other endangered aquatic fauna and flora, and enhance aquatic biodiversity	Increase in distribution record of aquatic endangered species such as *Platanista gangetica*, *Gavialis gangeticus*, and *Lutra perspicillata*	Species distribution survey
	Increase in aquatic flora and fauna species richness and abundance	Periodic biodiversity assessment
To improve fish productivity in and around the sanctuary	Increase in brood and fish stocks	Brood and stock sampling
	Increase in the establishment of fish ponds by local people	Field visit and household survey/interviews

6. Sustainable management of the fish sanctuary

A stakeholder involvement plan and management committee formation plan will be formulated to provide an equal opportunity for each individual and stakeholder to actively participate and gain benefits from the fish sanctuary. After forming a management committee, the tenure of each formulated committee will plan for short-term (>5 years) sustainable management plan. The committee will also formulate an operational plan to manage the fish sanctuary. A management plan will include short term and long-term goals and vision with major management and conservation issues in the fish sanctuary and their recommended actions to minimize the pressure. Furthermore, the operational plan will include the details of boundary demarcation, month-wise annual activities such as when and how much fish to harvest or other river resources extraction such as gravel and log, where and when to conduct river cleaning campaign, awareness campaign, biodiversity assessment, stock, and brood mapping, water quality monitoring restoration activities, and sedimentation survey, etc. The operation plan will also have detailed information on permitted fishing practices, a checklist of hunting allowed fish and no hunting fishes, price of each harvested fish, permissible quantity to hunt and supply to the market, etc. If some species need critical conservation attention, local level keystone species action plans particularly focusing on such species will also be formulated. Further, without an appropriate budget disbursement sustainable goal cannot be achieved hence, in each year total estimated financial plan will be prepared and expenses on each activity will be monitored carefully throughout the year.

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Annexes

Annex 1. Potential watershed for fish sanctuary in Karnali River basin

Watershed	District	Local Body (Nagarpalika/Gaunpalika)	Area of local body (km2)	Area coverage by WS (km2)	Passed acts/bills
West Seti (327)	Bajura	Gaumul Gaupalika	315	2	
	Doti	Khaptad National Park	95	7	
	Bajhang	Chabispathivera Gaunpalika	116	116	AABCA- 2077
		Durgathali Gaunpalika	62	61	
		Jaya Prithivi Nagarpalika	167	167	AABCA-2076
		Kanda Gaunpalika	1413	86	
		Kedarseu Gaunpalika	114	59	
		Khaptad National Park	70	70	
		Khaptadchhanna Gaunpalika	114	114	
		Masta Gaunpalika	109	109	
		Surma Gaunpalika	271	268	
		Talkot Gaunpalika	335	324	AABCA-2076
		Thalara Gaunpalika	106	103	AABCA- 2077
		Total	3287	1486	
Thuligaad (332)	Doti	Badikedar Gaunpalika	333	243	AABCA-2076
		Jorayal Gaunpalika	419	396	AABCA-2076
	Kailali	Chure Gaunpalika	493	165	AABCA-2076
		Mohanyal Gaunpalika	627	81	AABCA-2076
		Total	1872	885	

Middle Karnali (333)	Achham	Kamalbazar Nagarpalika	121	56	
		Panchadewal Binayak Nagarpalika	148	147	
		Ramaroshan Gaunpalika	173	3	
		Turmakhad Gaunpalika	232	118	
	Dailekh	Aathabis Nagarpalika	168	168	AABCA-2075
		Bhairabi Gaunpalika	110	33	
		Chamunda Bindrasaini Nagarpalika	91	91	AABCA-2075
		Dullu Nagarpalika	157	59	
		Thantikandh Gaunpalika	88	88	AABCA-2075
	Kalikot	Naraharinath Gaunpalika	144	138	
		Total	1432	901	

*Aquatic Animal and Aquatic Biodiversity Conservation Act (AABCA)

Annex 2: Consultation with Palika level stakeholders

Title: River stretch conservation at local level: Fish Sanctuary delineation protocol

Date: 26th Kartik 2077 (11th November 2020)

Time- 11.30 AM to 1.00 PM

Zoom Meeting

List of Participants

SN	Name	Designation	Affiliation and Address
1	Mr. Dhir Bahadur Shahi	Chair person	Thatikadh Rural Municipality, Dailakh
2	Mr. Khadga Prasad Upadhaya	Mayor	Aathbis Municipality, Dailakh
3	Mrs. Sunita Dhami	Executive Member	Jaya Prithvi Municipality
4	Mr. Bhuwaneshor Upadaya	Chair	Thalara RM, Bajhang
5	Mr. Mangal Bahadur Khadka	Citizen Scientist	CSO, Bajhang
6	Dr. Kedar Rijal	Professor	CDES-TU, Kathmandu
7	Dr. Deepak Rijal	Chief Technical Specialist	Paani Program, Kathmandu
8	Ms. Bhumika Sunuwar	Program Officer	RHF, Lalitpur
9	Ms. Sushila Bajracharya	EGH Coordinator	RHF, Lalitpur
10	Mr. Nirmala Koju	Assit. Researcher	RHF, Lalitpur
11	Mr. Bhuwan Singh	Field Coordinator	Bajhang
12	Mr. Kamal Khatri	Field Coordinator	Sarbodaya Nepal, Jumla
13	Dr. Dinesh Neupane	Program Director	RHF
14	Mr. Lal Bahadur Bista	Chair	Talkot RM, Bajhang
15	Dr. Ramji Bogati	Project Coordinator	RHF, Lalitpur

Annex 3. Consultation meeting with Province level stakeholders

Title: Fish Sanctuary delineated protocol: Riverscape level Aquatic Biodiversity Conservation

Date: 3rd Mansir 2076 (18th November 2020)

Time- 11.30 AM to 1.00 PM

Zoom Meeting

List of Participants

SN	Name	Designation	Affiliation and Address
1	Mr. Sher Bdr Shrestha	Senior Watershed Management Officer	MoITFE, Karnali
2	Mr. Gopal Sharma		Ministry of Physical Infrastructure Development (MOPID), Karnali province
3	Mr. Sher Bdr. Rokaya	Assit. Forest Officer/ Private Sec.	MoITFE
4	Mr. Ramesh Subedi	CDE	Water Resource and Energy Development Division, MoPID
5	Mr. Niroj Shrestha	Assit Soil Conservation Officer	MoITFE, Sudurpachim, Dhangadi
6	Dr. Sarad P. Mohapatra	Researcher	India
7	Mr. Pravat Pal		Rastrapati Chure, Kailali
8	Mr. Arun Poudel	GIS expert	Paani Program, Kathmandu
9	Mr. Suresh Wagle	Specialist	Paani Program, Kathmandu
10	Dr. Kedar Rijal	Professor	CDES-TU, Kathmandu

11	Dr. Deep N. Shah	Assit. Prof.	CDES-TU, Kathmandu
12	Dr. Deepak Rijal	Chief Technical Specialist	Paani Program, Kathmandu
13	Ms. Bhumika Sunuwar	Program Officer	RHF, Lalitpur
14	Ms. Sushila Bajracharya	EGH Coordinator	RHF, Lalitpur
15	Ms. Nirmala Koju	Assit. Researcher	RHF, Lalitpur
16	Ms. Bhuwan Singh	Field Coordinator	Bajhang
17	Ms. Kamal Khatri	Field Coordinator	Sarbodaya Nepal, Jumla
18	Ms. Bhupendra Shahi	River Basin, Team Leader	Paani Program, Surkhet
19	Dr. Ramji Bogati	Project Coordinator	RHF, Lalitpur

Annex 4. National level consultation meeting

Title: Fish Sanctuary delineated protocol: Riverscape level Aquatic Biodiversity Conservation

Date: 10th Mansir 2076 (25th November 2020)

Time- 11.00 AM to 12.30 PM

Zoom Meeting

List of participants

SN	Name	Designation	Affiliation and Address
1	Ms. Santoshi Shrestha	Asst. Professor	CDZ-TU, Kritipur
2	Dr. Tek Gurung	Eminent Researcher	NARC, Lalitpur
3	Mr. Megh Ale	Chair	NRCT, Kathmandu
4	Dr. Vishnu Pandey	Researcher	IWMI, Kathmandu
5	Dr. Madhav Karki	Free lancer	
6	Mrs. Nilu Basnyat	CoP	USAID Paani Program
7	Dr. Deepak Rijal	Chief Technical Specialist	USAID Paani Program
8	Dr. Kedar Rijal	Professor	CDES-TU
9	Dr. Deep Narayan Shah	Asst. Professor	CDES-TU
10	Dr. Narendra Man Babu Pradhan	Expert	IUCN, Nepal
11	Ms. Bhumika Sunuwar	Program Officer	RHF, Lalitpur
12	Ms. Sushila Bajracharya	EGH Coordinator	RHF, Lalitpur
13	Ms. Nirmala Koju	Assit. Researcher	RHF, Lalitpur
14	Mr. Bhuwan Singh	Field Coordinator	RHF, Bajhang
15	Mr. Kamal Khatri	Field Coordinator	Sarbodaya Nepal, Kalikot
16	Dr. Dinesh Neupane	Program Director	RHF, Lalitpur
17	Mr. Pramod Rijal		CFPCC
18	Dr. Ramji Bogati	Project Coordinator	RHF, Lalitpur